AMEC Project Summary:
GIS ENABLED METOC PRODUCTS

Project No: TQ10001 Contract Number: W7707-098219/001/HAL Contract Scientific Authority: Dr. Cristina Tollefsen +1-902-426-3100 x 226	Date: January 31, 2012 Version 1.1 Prepared by: J. Chris Innes, Project Manager AMEC Environment & Infrastructure 210 Colonnade Road South, Suite 300 Ottawa, Ontario, Canada *+1-613-727-0658 -phone* *+1-613-727-9425 -fax* chris.innes@amec.com

Contract Report
DRDC-RDDC-2015-C029
January 2012

Revision History

Date	Version	Description	Author
January 2, 2012	1.0	Original	Chris Innes
February 10, 2012	1.1	Document Review	Ted Reeler

AMEC Internal Review	Signature
AMEC Reviewer: Ted Reeler	
Date: February 10, 2012	

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GIS Enabled MetOc Products

1. Introduction

1.1 Purpose

The purpose of this document is to provide a project review for the GIS Enabled MetOc Products Project (the Project) contracted by DRDC Atlantic in January 2010 to AMEC Environment & Infrastructure.

1.2 Scope

The scope of the Project was to make improvements to the AMEC Forecaster system, and to research possibilities of adding new weather data products that would help support DRDC's Mission Planning Tool (MPT).

1.3 Definition

AMP	Air Mass Parameter
DFO	Department of Fisheries & Oceans
DRDC	Defence R&D Canada, Atlantic
DND	Department of National Defence
EC	Environment Canada
ESRI	Environmental Systems Research Institute Inc.
GIS	Geographic Information System
FTP	File Transfer Protocol
GRIB	GRIdded Binary data
KML	Google Keyhole Markup Language
KMZ	Google Keyhole Markup Language (Compressed)
MetOc	Department of National Defense Meteorological and Oceanographic Support, Halifax
MPT	DRDC Mission Planning Tool which is based on Satellite Toolkit Common Application Framework
MSC	Meteorological Service of Canada (Environment Canada)
STK	Satellite Toolkit Common Application Framework

2. Overview

This section provides an overview of the major components that comprised the Project.

2.1 Meteorological and Oceanographic Weather Data Feeds

AMEC, under contract to DND MetOc Halifax in 2008-2009, developed the AMEC Forecaster as an automated system to create GIS enabled weather data products in the Google Earth KMZ and ESRI Shapefile formats.

This project required upgrading to the GRIB input data format as a result of the data provider (MSC) changing the data format. The project also required hosting the updated AMEC Forecaster application until the R&D products in the following section were created and until such time as DND MetOc Halifax were in a position to upgrade their copy of the application and provide the new Shapefiles directly to DRDC Atlantic.

2.2 Research & Development into new Weather Products

While the existing AMEC Forecaster produced many weather related products, DRDC identified several new products as required inputs for MPT. The focus of this part of the project was to research, and where possible extend, the AMEC Forecaster to support these additional weather products.

3. Findings

3.1 Meteorological and Oceanographic Weather Data Feeds

3.1.1 GRIB File format update

The original requirement: Install and troubleshoot the AMEC Forecaster at the offices of MetOc Halifax by April 26, 2010 including: updating .kmz capability and support for the new format from Meteorological Services of Canada that is being implemented on April 26, 2010.

When the project started MSC announced that they were in the process of upgrading the metrological data feeds. This MSC upgrade would result in the existing AMEC Forecaster ceasing to function as of April 26, 2010. Therefore the AMEC Forecaster was upgraded to support the new MSC format and directory structure and installed at DND MetOc Halifax the first week of March 2010.

3.1.2 Hosting of the AMEC Forecaster

The original requirement: Post the GIS-enabled MetOc products on the contractor's website from contract Initiation until December 31, 2010.

The original requirement: Post the GIS-enabled MetOc products on the contractor's website from January 1, 2011 until AMEC Forecaster has been installed at MetOc offices, and is working properly.

The contract included AMEC hosting the AMEC Forecaster application at the AMEC Data Center in Toronto. This provided DRDC with a method to access the weather data products and enabled development of MPT to proceed. Initially the application hosting was to be completed by December 2010. DRDC requested that the hosting be extended until such time as DND MetOc Halifax was able to provide a replacement service to DRDC. In August DND MetOc Halifax was successful in providing the replacement service to DRDC and AMEC ceased to host the application.

3.2 Research & Development into new Weather Products

This section is broken down based on the requirements.

3.2.1 Resolve missing data from the source data streams.

The original requirement: Resolution of problems caused by data missing from the source data streams.

This requirement presented itself because there were data gaps in various weather products. To resolve the missing data issue AMEC worked with MetOc Halifax to obtain examples of products with missing data. AMEC then modified the AMEC Forecaster application to handle the special cases within the data that were causing data values to not be included in the product.

3.2.2 Improve the intersection of GIS enabled MetOc products with the area of interest.

The original requirement: Work is required to improve the intersection of GIS-enabled MetOc products with boundaries of the Area of Interest selected by the user.

The original requirement: Resolve rendering problems encountered at the Intersection of GIS-enabled MetOc products with boundaries of the Area of Interest selected by the user.

AMEC created the ability to crop data based on a land water interface. This ability exists when creating the Shapefile outputs and is not supported with the NetCDF outputs. This ability requires a land water interface Shapefile. The scale of the land water interface Shapefile directly relates to the performance of the application when cropping the data in that a large scale Shapefile, i.e., 1:5000 takes considerably more time to process than a smaller scale Shapefile, i.e., 1:50000 due to the complexity of the data involved.

3.2.3 Work with DRDC to improved rendering of KML within STK.

The original requirement: Work with DRDC Atlantic scientists to improve display of products in Satellite Toolkit Common Application Framework which does not use a standard form of KML rendering.

This requirement was related to the rendering of the AMEC KML datasets within STK. AMEC researched this requirement and determined the problem was with STK and not with the AMEC KML datasets. The STK vendor resolved the KML issues with a patch to their program.

3.2.4 Work with DRDC to auto scale objects.

The original requirement: Work with DRDC Atlantic scientists to provide more options for

graphical display of objects with the goal of auto-scaling level of detail in products appropriate for zoom level use in the GIS. This de-clutters the image when the GIS is zoomed out.

This requirement centered around too many objects appearing on the map when viewing a small scale map covering a large geographic area. This requirement was resolved by adding a configuration option to the AMEC Forecaster that allows the administrator to provide control what percentage of the input sample points are published in the output product thus allowing he operator to create a series of products for use as different scales.

3.2.5 Produce standard weather chart that allows background imagery to show through.

The original requirement: Product a weather chart layer that has all the graphical attributes of a standard weather chart but allows the background imagery (map or terrain) to show through.

This requirement was achieved in two steps. In step one the user was given the ability to load a series of KML files which together represent a standard weather chart while in the second step the vendor of STK provided an update to the application to allow transparency of KML files thus enabling the overlay of multiple KML files at the same time.

3.2.6 Interview CF members to solicit ideas for future improvements.

The original requirement: Interview Canadian Forces end users at the contractor's location to solicit ideas for future improvements to products or for entirely new products. Other improvements are anticipated as the end users gain experience with existing products.

This requirement was removed from scope via amendment number 3 on April 4, 2011.

3.2.7 Provide a convenient GIS enabled tide product extracted from DFO sources.

The original requirement: Provide a convenient GIS-enabled tide product that will extract data from DFO sources, tide gauges and possibly other sources and provide comprehensive information on tides (time of high/low tide, tide height and tidal currents) anywhere along the coast of Canada. This information is required as current information ("nowcast") and forecast.

This requirement required a facilitator to arrange a data sharing arrangement between DFO, MetOc and DRDC. AMEC facilitated DFO sharing their tide data with MetOc Halifax in trade for MetOc Halifax providing DFO with access to their DALCOAST data. Permission was also required and received from Dalhousie University for MetOc to share the DALCOAST data with DFO. The end result was the ability for DRDC to access both the DFO tide data along with the MetOc DALCOAST data via the MetOc FTP site.

This requirement was removed from scope via amendment number 3 on April 4, 2011 prior to AMEC creating a method of DRDC or MetOc to ingest the tide and DALCOAST data into the AMEC Forecaster.

3.2.8 Provide AMEC Forecaster support to MetOc Halifax.

The original requirement: Work with MetOc Halifax to validate their implementation of the existing GIS-enabled MetOc products, provide technical support for displaying the products on DND's Command View system and publishing the data on the Canadian Forces Weather-Oceanography Server (CFWOS).

AMEC provided MetOc Halifax with support to install, configure and manage the AMEC Forecaster as requested by MetOc Halifax.

3.2.9 Investigate the feasibility of adding humidity as a product to the AMEC Forecaster.

The original requirement: Investigate the feasibility of updating the AMEC Forecaster software capability to produce the following GIS-enabled MetOc products: Humidity (at a single point, e.q. 2 m above the surface)

This requirement involved research and development into the possibility of creating a humidity data product. Research determined that the required data existed to create a new relative humidity data product. The AMEC Forecaster was updated to allow for the creation of the new relative humidity data product.

3.2.10 Investigate the feasibility of adding air mass parameter as a product to the AMEC Forecaster.

The original requirement: Investigate the feasibility of updating the AMEC Forecaster software capability to produce the following GIS-enabled MetOc products: Air Mass Parameter (AMP).

The air mass parameter (AMP) is a dimensionless parameter used in the US Navy Aerosol Model. It can be estimated in a variety of ways; primarily it seems on atmospheric radon concentration, condensation nuclei, visibility and air mass indices amongst others. Currently there appears to be no certain techniques or sensors that would estimate any of these quantities 24 hour per day over the entire earth or a significant portion of the earth. Various satellites and sensors may measure one or more quantities but they are either in the visible spectrum or polar-orbiting. Currently none of the standard numerical weather models operated by NOAA (or others) predicts any of these quantities. However, some studies suggest that aerosol characteristics from the Weather Research and Forecasting Model with Chemistry (WRF/Chem) has the potential to estimate cloud condensation nuclei which could be used to calculate AMP. It is currently unknown if WRF/Chem would actually produce cloud condensation nuclei estimates on its own or do so with sufficient accuracy. Further research into WRF/Chem is recommended.

3.2.11 Investigate the feasibility of adding cloud extinction as a product to the AMEC Forecaster.

The original requirement: Investigate the feasibility of updating the AMEC Forecaster software capability to produce the following GIS-enabled MetOc products: cloud extinction (e.g., 05, 25%, 50%, 75% and 100%).

This requirement involved research and development into the possibility of creating a cloud extinction data product. The definition of cloud extinction as provided by DRDC is as follows:

“Cloud extinction deals with the absorption during propagation through clouds - these are co-efficients assuming exponentially damped transmission exp(-kl) where k is the extinction parameter and l is the thickness of the cloud/absorber. k depends on cloud type, and the wavelength of light...”

After extensive research by AMEC’s Meteorological and Oceanographic experts and after discussion with DRDC’s Dr. Zahir Daya it was recommended by DRDC that AMEC not create a cloud extinction product but rather create four cloud products that would be used by DRDC as inputs to their computation of cloud extinction. The four new products that were created are; cloud cover (% coverage), cloud height and thickness, and cloud type. These four new products were created and published through the AMEC Forecaster.

3.2.12 Investigate the feasibility of adding profiles of ocean water temperature and salinity as a function of depth.

The original requirement: Investigate the feasibility of updating the AMEC Forecaster software capability to produce the following GIS-enabled MetOc products: profiles of modeled and/or measured ocean water temperature and salinity as a function of depth.

This component was achieved in two steps. In step one the AMEC Forecaster was updated to allow for the creation of ocean water temperatures and salinity with a depth parameter thus allowing the administrator to specify the depths by which the production will be created. This output was created in the ESRI Shapefile format. In step two DRDC reviewed the ESRI Shapefiles and determined that creating the files in NetCDF format would result in easier integration with the DRDC toolset. AMEC extended the AMEC Forecaster tool to export NetCDF files to allow the ocean water temperature and salinity outputs to be created in NetCDF format.

4. Next Steps

This section presents the next steps in the form of a list of items that require DRDC would benefit from with the continued use of the AMEC Forecaster.

4.1 Additional Research

AMEC throughout this project was able to successfully extend the list of meteorological datasets available to DRDC, and output formats for these datasets, which can then be used as inputs to the DRDC MPT and other application.

There remain a few areas that would benefit from additional research.

4.1.1 Air Mass Parameter (AMP)

AMEC was, towards the end of the contract, able to identify a possible model source for the creation of the AMP but the effort to create and properly test the model was beyond the budget and time scope of this project. AMEC recommends additional time and effort be placed into the research of using the WRF/Chem model/parameter for the calculation of AMP.

4.1.2 Tides

The requirement to provide a convenient GIS-enabled tide product that will extract data from DFO sources, tide gauges and possibly other sources and provide comprehensive information on tides (time of high/low tide, tide height and tidal currents) anywhere along the coast of Canada was removed from scope of the project but AMEC feels future work on this product is warranted.

During the project AMEC was able to lay the ground work to gain access to the tide data but not to actually process the data.

5. Summary

AMEC would like to express its pleasure in providing services to DRDC and its desire to continue helping DRDC advance its Meteorological and Oceanographic services. At the start of this project AMEC maintained Meteorological teams in St. John's Newfoundland and Halifax Nova Scotia. Nearing the end of the project AMEC added an additional Meteorological team in Ottawa Ontario. The new Ottawa Meteorological team brings to the table years of Meteorological research and many ideas (the WRF/Chem option for Air Mass Parameter) which can be utilized by DRDC in advancing their desire for additional Meteorological and Oceanographic data.